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Studies in Macadam Road Design

By A. T. GOLDBECK, *Director*

Bureau of Engineering

National Crushed Stone Association

(*Continued from April Issue*)

In the April 1, 1926, issue of this Journal consideration was given to some of the general fundamental principles underlying the cross-section design of roads of the flexible type. It was stated that there were certain well-defined lines along which the macadam, or flexible type road, might be revised from the standpoint of improving its load-carrying capacity.

The desired changes should be directed toward:

A. The improvement of the drainage of the sub-grade.

B. The prevention of clay intrusion into the broken stone surfacing.

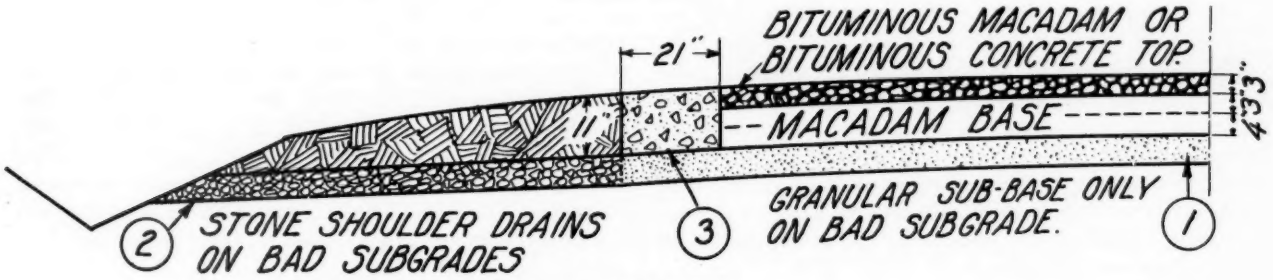
C. An increased load bearing capacity at the edges of the road.

(a) To provide greater lateral support at the edges.

(b) To decrease the ratio of subgrade pressure to subgrade resistance.

Studies have been undertaken in the cross-section design of bituminous macadam roads to see if the above objects might not be accomplished without an appreciable increase in cost over that of present standard construction. A number of these studies are presented herewith for consideration while a number of other cross-sections which have suggested themselves have been discarded as being either too costly or of very doubtful value.

For the purpose of comparison a so-called "standard cross-section" will be used. This consists of an 18-foot bituminous macadam pavement having a total uniform thickness of 11 in. with a 3-in. bituminous macadam top, laid on a 7-in. base, constructed in two courses, 4 in. and 3 in. in thickness, respectively. This approximates one of the present state standard cross-sections and with this "standard" as a basis it will be interesting to consider the various forms of cross-section proposed in order to study the probable value of the suggested changes in design. Admittedly, the estimates of costs of these cross-sections are apt to be faulty but are probably close enough for purposes of general comparison.



Features—1 Use of sub-base of granular materials to
(a) Reduce intensity of pressure on sub-grade.
(b) Serve as cut-off layer to prevent intrusion of clay into macadam.
(c) Reduce capillary moisture in subgrade.
(d) Drain surface of subgrade and prevent accumulation of free water.
2 Use of stone shoulder drains to
(a) Drain sub-base and subgrade.
3 Use of concrete curb to
(a) Stabilize side of macadam against lateral displacement.
(b) Prevent breaking down of edges of macadam thus making for greater width.
(c) Provide a light colored border thus aiding in night driving.

FIGURE I

Figure I.

Figure I has as its main features:

1. The use of a sub-base of granular material consisting of clean bank-run gravel, stone screenings, cinders and like materials which will serve:

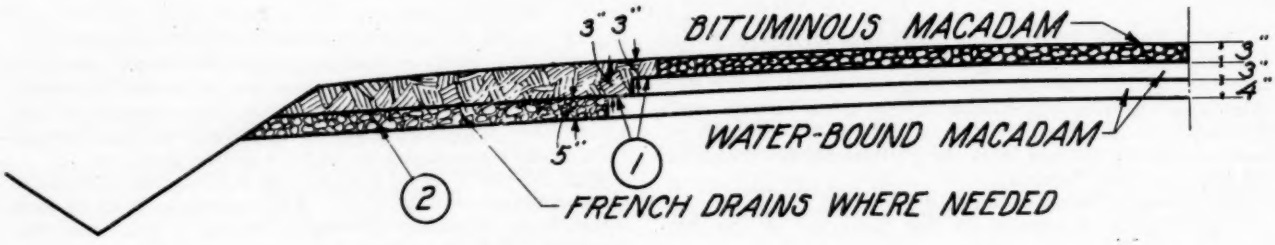
   (a) To reduce the intensity of pressure on the subgrade.

   (b) To act as a shut-off layer to prevent the intrusion of clay upward into the macadam base.

   (c) To reduce the capillary moisture in the subgrade.

   (d) To drain the surface of the subgrade and prevent the accumulation of free water.

driving. This section has been reduced from 11 in. to 10 in. in thickness at the center for it is believed there is much more likelihood of the subgrade having higher supporting value at the center than at the sides during critical periods of the year, and moreover, at the center, the load is more widely distributed over the subgrade than near the edges of the macadam. It is estimated that this type of cross-section will cost approximately $5,500 a mile more than the standard cross-section. This additional expenditure is warranted only if a saving in annual maintenance cost of 5 per cent of $5,500 or $275 is effected thereby. Although such a section should require less maintenance to keep the edges in good condition, it becomes a question as to whether or not this saving warrants the extra expense for concrete curbs. It also becomes a question as to how favorably the annual cost of a cross-section of this type would compare with that of other types of pavements suitable for similar conditions of traffic. It is probable that this section would be more expensive in first cost than a suitable section of concrete. The behavior of concrete curbs under severe freezing conditions is also open to some question.



Features—1 Stepped construction at edge to better distribute subgrade pressures.
2 French drains where needed to promote dry subgrade.

FIGURE II

This layer is suggested only where the road is to be laid on an exceptionally bad subgrade, and it is presupposed that where such a layer will be necessary for the macadam type it generally will be necessary for roads built of other types. Such a layer probably had better not be less than 6 in. in thickness, although even a thinner one would be of considerable value in preventing intrusion of clay into the stone.

2. In connection with this layer, wide and frequently spaced stone shoulder drains should be used, for otherwise a reservoir will be created which might actually cause increased softness of the subgrade.

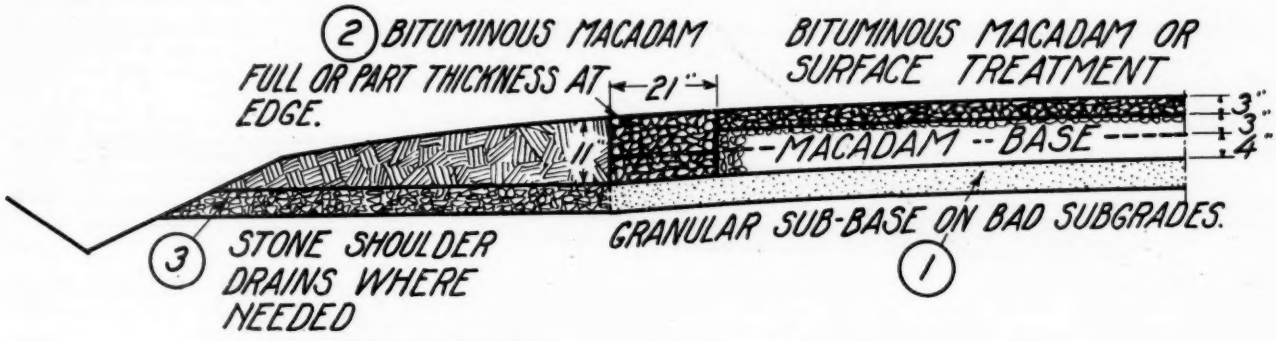
3. To strengthen the outer edges of the pavement, concrete curbs are provided 11 in. in thickness and 21 in. in width. These dimensions were calculated so that this cross-section would have about the same beam resistance as the concrete shoulders used successfully in the State of Maryland. Such a curb stabilizes the macadam against lateral displacement, prevents the breaking down of the edges of the bituminous surfacing, thus making for greater effective width and provides a light colored border which has been found to be of advantage in night

Figure II.

In Figure II, proposed by H. M. Sharp, formerly Chief Engineer of the Ohio State Highway Department, it will be noted that the first and second base courses are each laid with an extension of 6 in. beyond the course above. Reference to the curves of distribution of pressures, shown in Figure 1 on page 7 of the April 1st issue of The Crushed Stone Journal, will show that such a design is logical for it provides extra bearing area for the load when placed at the edge of the pavement. In this type of construction, wherever necessary, French drains should be used to help insure a dry subgrade. This cross-section is likewise decreased in thickness one inch at the center as compared with the standard cross-

section. It costs approximately $500 per mile more than the standard cross-section and, in comparison, would have to show a saving in yearly cost of 5 per cent of $500 or $25.00 per mile. There should be less breaking down at the edges on a pavement of this type as compared with the standard type and such a section would very likely be a more economical section than the standard cross-section, also, because of its comparatively low first cost it should compare very favorably with competing types of pavements.

at the rate of 5 gallon per sq. yd. for the full depth, this section costs approximately $800 per mile more than the standard section. If the extra thickness of bituminous macadam is extended only through the second base course such a section would cost approximately $200 more than the standard section. It would seem that considerable benefit might result through the stiffening effect of the bituminous material applied either through the full depth or part depth at the edges of the road.



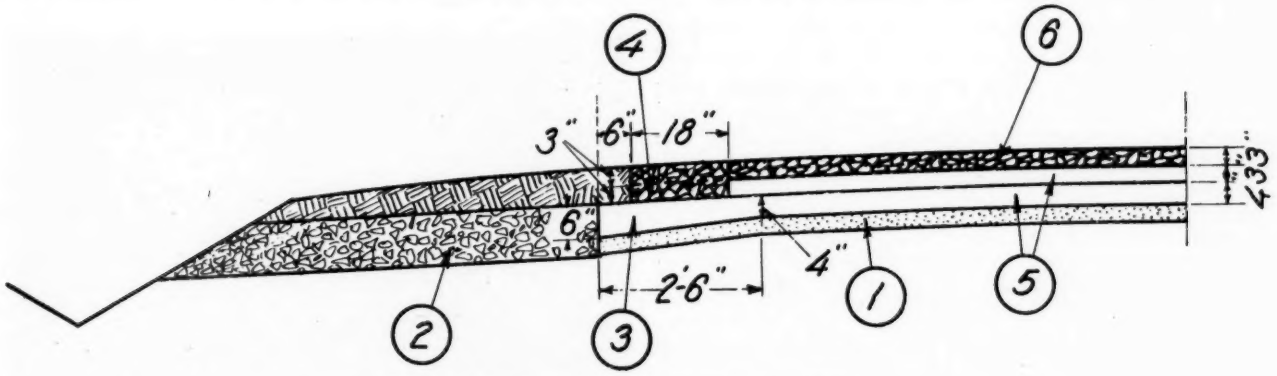
Features—1. Use of granular sub-base .
2. Use of bituminous macadam at edges of road using hard bituminous binder throughout depth to increase both vertical and lateral strength at edges.
3. Use of stone shoulder drains to drain sub-base.

FIGURE III

Figure III.

In Figure III the essential feature is the use of penetration macadam edges, either in the second base course or throughout the whole depth of the pavement, extending over a width of 21 in. from the sides. The center thickness has been decreased to 10 in. instead of 11 in. as in the standard section. In the case of a bad subgrade a granular sub-base and stone shoulder drains should likewise be provided. Figuring on the basis of a full depth penetration of bituminous material at the sides

Variations in this design can well be worked out to very good advantage and in Section IIIa such a design, proposed by Carl L. Van Voorhis, Chief Engineer of the Ohio Crushed Stone Association, is shown. Note that in this design use is made of thickened and extended edges in the base course, and the bituminous penetration is extended through the second base course at the sides. This section would cost approximately $100 more than the standard, but has features which recommend it as an improved design.



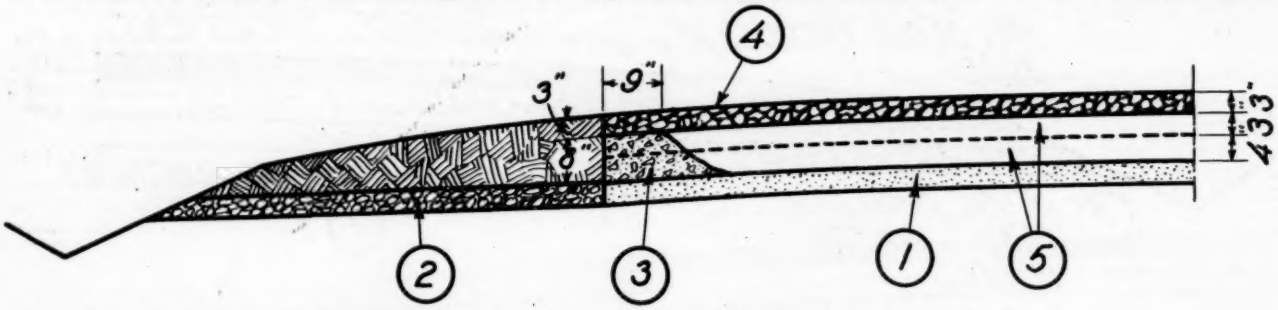
Features—1. Use of Granular sub-base on bad subgrades.
2. Use of stone shoulder drains where needed.
3. Thickened and extended base.
4. Bituminous macadam edges in second base course.
5. Water-bound macadam base.
6. Bituminous macadam or surface treated top.

Figure III A

Figure IV.

In Figure IV is shown a type of construction which has been included in these studies as a section which offers interesting possibilities. Notwithstanding its very radical features it should be well worth building experimentally. The proposal is to construct the various courses of broken stone as they would normally be constructed with the exception that the first and second base courses would be filled with screenings only over part width instead of full width, thus leaving a narrow strip

A more practical and more economical method than the above has been suggested by R. W. Coburn, Construction Engineer of the Massachusetts Highway Department. It consists of using a dry mixture of Portland cement and sand as the filling material in the stone base course or courses and depending either upon artificially or naturally applied moisture to set up the cement. This method was tried by the writer on a small scale and in Figure V is shown a view of the specimen after the cement had hardened. Unquestionably such a



Features—1 Use of fine granular sub-base on bad subgrades.
2 Use of stone shoulder drains where required.
3 Portland cement grouted curb to strengthen edges, formed by filling voids either with liquid grout or dry cement-sand filler.
4 Bituminous macadam top.
5 Water-bound macadam base.

FIGURE IV

of unfilled stone at the sides. After rolling of the three courses is completed, it is proposed to pour the side strips not quite full of calcium chloride-accelerated Portland cement grout in the proportions of 1:2, thus forming a grouted-in-place concealed concrete curb of the cross-section shown. Later the bituminous macadam course would be poured and finished in the usual manner. It is felt that such a curb would greatly add to the vertical and horizontal stability of the pavement at the edge. In time it probably would crack transversely at frequent intervals and would then act in practically the same way as large hand placed stones held firmly in position. Considerably increased support of the pavement edges should result both vertically and laterally. The cost of the grouting would be, roughly, $1,300 per mile, and the net increase in the cost of this section over the standard cross-section would be approximately $700, a yearly increased cost of $35.00 which would have to be saved through decreased maintenance. Where bad subgrades are encountered, a granular sub-base and stone shoulder drains should be provided also.

The use of Portland cement grout along the edges has some disadvantages, chief among which are (1) the necessity for having extra equipment on the job, such as a grout mixer and its appurtenances, (2) the uncertainty of the desired degree of penetration of the grout and, (3) the necessity of subjecting the grouted edge to the weight of the roller during the rolling of the bituminous macadam top.

method would add to the strength of the edges of a bituminous macadam pavement and the expense would not be unreasonable, probably not over $1,000 per mile for the formation of curbs of the cross-section shown in Figure 5. Taking into account the decreased cost of this section due to the use of less stone in the center the net increase would then be about $400. This idea of using a dry filler of cement and sand or cement and stone screenings along the edge is most certainly worthy of a practical trial.

FIGURE V
Experimental Slab with cement-sand filled curb.

All of these sections should require less maintenance expense because they are strengthened along the edges where the present design is weakest. Generally side

(*Continued on page 8*)

The President's Page

Freight Rate Hearings Open In Washington

As this issue of the Journal goes to press, argument is being heard by the Interstate Commerce Commission in Washington in proceedings Ex Parte 87 under Docket 17000, being the petition of the western carriers to increase the rate on various commodities, among which is crushed stone. If the petition of the carriers is granted, it will result in an increase in freight rates on crushed stone of 7½c per net ton.

We have been represented in this hearing by the firm of Walter, Burchmore and Belnap and Mr. Burchmore will argue in our behalf before the Commission on or about May 26th. We have submitted to the Commission a printed brief, a copy of which can be secured, as long as the supply lasts, upon application to our counsel.

We are informed that some three hundred representatives of various commodity interests will appear in oral argument before the Commission. In a proceeding so comprehensive as to involve as many commodities as this would indicate, it would have been indeed unfortunate had we not intelligently endeavored to forcefully and vigorously present to the Commission through testimony, brief and oral argument our opinion that crushed stone is already affording the carriers its full share of the revenue required. We are of the opinion that no increase in freight rates will be placed upon crushed stone at this time.

* * * * * * * * * *

Speaking of freight rates, the following quotation from a recent decision of the I. C. C. is of significant interest:

> *"Generally speaking, there is no transportation reason why the rates on sand and gravel should be higher than the rates on slag or crushed stone. In most territories, and in the States, they are given the same rates, and where we have prescribed scales in any territory on all of them they have been rated the same. The rates complained of, considered as a whole, are clearly too high."*

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Bureau of Engineering is Commended on Macadam Article

Those who attended the banquet during the Montreal Convention will recall with interest and pleasure the address delivered at that time by Mr. Charles Upham, State Highway Engineer of North Carolina. Mr. Upham is an engineer of broad vision and varied experience and is a recognized authority on highway construction. In addition to his work in North Carolina, he is consulting highway engineer for the Republic of Mexico and director of the National Highway Research Board. We print the following extract of a letter recently received from him, because it is distinctly encouraging to know that distinguished engineers catch the vision and are in accord with the work we have undertaken:

> *"While I was in Mexico, I received a copy of The Crushed Stone Journal, in which appeared a treatise by Mr. Goldbeck on macadam construction. This came at an opportune time in Mexico, inasmuch as we were right in the midst of a macadam program. I had this article copied and distributed to the engineers. This is about the first time I have seen a treatise on macadam construction that has gone into the matter practically, as well as technically, and made the information readily understandable.*
>
> *"I also want to say again what I have told you personally, that I think you have made a wonderful step by securing the services of Mr. Goldbeck. He has immediately added to the industry the technique of one whom I consider to be one of the best engineers in the country, and at the same time he has demonstrated in a very practical way the big advantage to all concerned of a closer association between the professional engineer and the industry."*

We realize that Mr. Upham as a road builder seeks to build the best possible roads at the lowest initial cost, with due regard to subsequent maintenance costs, and we quite agree with him that the introduction of scientific investigation into our industry must ultimately be of tangible benefit to consumer and producer alike.

* * * * * * * * * *

Ohio Crushed Stone Association Makes Generous Contribution

A pleasant surprise in our mail a few mornings ago was a letter from Mr. Evans, President of the Ohio Crushed Stone Association, informing us that at a recent meeting it was voted to contribute the sum of one thousand dollars to the National Association for the remainder of the year 1926. Mr. Van Voorhis, Chief Engineer, also wrote us concerning this welcome support, expressing his pleasure in being able to be of assistance.

We are indebted to the Ohio Association for this action, not only because of the financial value of their gift, but also because it evidences their sympathy with, and support of, the work we have undertaken. Until such time as our finances can be placed on the firm foundation of deriving our revenue directly from dues paid into the association treasury, we must be dependent upon the

voluntary contributions of individual producers and local associations and during this period of experimentation and evolution we are grateful for such gifts as will enable us to continue to test what merit may lie in our belief that scientific study, research and investigation of the ways and manner in which crushed stone is used and produced, and its relative economic value in comparison with other aggregates, will be of real value to consumers and producers of this product. We thank the Ohio Association for this contribution, bringing them in line, as it does, with those others who are generously supporting and rendering possible our varied association activities.

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Report of Investigation of the Economic Value of Reinforcement in Concrete Roads Now Available

At the last annual meeting, held in the early part of December, 1925, of the Highway Research Board several members of our Association had the pleasure of hearing the report of Mr. Hogentogler of his investigation of the economic value of reinforcement in concrete roads. We were so impressed by the contribution this survey had made, the knowledge possessed on the subject, and its indirect relation to other phases of concrete construction and the materials used therein, that we requested permission for Mr. Hogentogler to address the Montreal convention on the subject of his investigations. Those who were so fortunate as to hear Mr. Hogentogler in Montreal will vividly recall the interest manifested in his address. We have just received a printed copy in full of his report and are again impressed with the worth while study which this investigation represents. If the supply has not been exhausted, a copy may be secured by writing Mr. S. S. Steinberg, Assistant Director, Highway Research Board, referring to the "Report of Investigation of the Economic Value of Reinforcement in Concrete Roads." We believe that everyone interested in road construction will find much material of value in this report and can study it carefully to advantage.

* * * * * * * * * *

Bureau of Engineering Instrumental in Initiating Concrete Aggregate Tests

Believing that information could be secured of value to highway building agencies, our Bureau of Engineering suggested certain investigations to the New Jersey State Highway Department and to the United States Bureau of Public Roads for their joint development. These tests as finally agreed upon by the cooperating parties are now well under way and in the May issue of "Highway Research News" is the following comment:

"The New Jersey State Highway Department, in cooperation with the U. S. Bureau of Public Roads, has begun a series of concrete tests for the purpose of studying the relative concrete-making properties of crushed stone and gravel used in concrete road construction in that State. The tests are being made in the State Highway Laboratory at Trenton, and involve the fabrication and testing of about 250 concrete beams 8" x 8" x 48" in size, as well as a large number of cylinders for compression tests.

"The program calls for three series of tests. In the first series the workability of the concrete is to be kept constant, as nearly as possible, by means of the flow test, and the relative yield and strength of the concrete determined for each of several gradations both of of crushed stone and gravel, using concrete proportions as given in the current New Jersey Standard Specifications. The object of this series is to determine the relative strength and yield of gravel concrete as compared with crushed stone concrete for several sizes and gradations of coarse aggregate.

"In the second series an effort will be made to design concrete of a given strength by means of the water-cement ratio theory, for each type and gradation of coarse aggregate. The procedure to be followed in this series is essentially as follows: To each gradation and type of coarse aggregate, fine aggregate will be added in the folloing ratios by volume: (a) 33:67, (b) 36:64, (c) 40:60. To each of the above combinations, water and cement in a fixed ratio, depending on the strength desired, will be added until the desired workability has been reached. The end point in each case will be determined by means of the flow test, supplemented by the judgment of experienced concrete operators. Concrete specimens will then be made up in the proportions as determined by the trial method referred to, and the comparative strength, which should be constant, the comparative yield, and the comparative absorption will be determined.

"In the third series of tests specimens will be made in which the concrete mixture has been designed in accordance with the fineness modulus theory as given in 'The Design and Control of Concrete Mixtures,' a publication recently issued by the Portland Cement Association. The results obtained from this series will be used as a check against the results obtained in the second series.

"Assuming a constant strength and a constant degree of workability, it is hoped to determine by means of these tests what grading of coarse aggregate and what proportions of fine to coarse will give the greatest yield of concrete for both crushed stone and gravel."

Local Association Activities

New York State Crushed Stone Association

The New York State Crushed Stone Association held its first meeting of the year at the Hotel Syracuse, Syracuse, New York, on Friday, April 23, with thirteen members present.

President Seitz, in opening the meeting, emphasized the need of greater attendance at the regular meetings of the Association and urgently requested that everyone do his utmost to increase the membership during this year.

Mr. Savage called attention to the fact that the balance of the pledge of $6,000 made towards the support of the Bureau of Engineering would shortly be due.

It was decided upon motion of Mr. Sporborg, seconded by Mr. McNasser that all previous action taken by the Association in relation to the adoption of a suitable emblem be rescinded and that the chair appoint a committee to look up a new emblem suitable for use by the individual membership. The appointment of the committee was deferred to a subsequent meeting.

President Seitz presented for consideration the new specifications for stone sizes as shown in the March 1 issue of the Crushed Stone Journal and asked for an expression of the meeting as requested in circular letter No. 2 of the National Crushed Stone Association.

After discussion it was decided upon motion of Mr. Sporborg, seconded by Mr. Heimlich, that it was the sense of the meeting that the proposed specifications do not meet with the approval of this Association. President Seitz was then authorized to appoint a committee for the purpose of drafting specifications more in accord with our needs, to be presented to Mr. Goldbeck, Director of the Bureau of Engineering.

Mr. Shaefer discussed the advisability of the Association's having prepared for educational purposes, a three or four reel moving picture depicting the production and uses of our product from quarry to completed work.

Miscellaneous subjects were then discussed after which the meeting adjourned.

Pennsylvania Stone Producers' Association

The regular meeting of the Pennsylvania Stone Producers' Association was held on Monday, May 3, at the William Penn Hotel, Pittsburgh, Pa.

Upon motion of Mr. Gilbert, seconded by Mr. McCrea, the Secretary was authorized to collect from the members by assessment the sum of $3,000 and remit same to the National Association as the balance due on the pledge of $6,000 made by this Association towards the support of the Bureau of Engineering.

A communication from F. C. McKee giving the recommendations for changes in the regulations for mines, other than coal mines issued January, 1926, by the Department of Labor and Industry of the Commonwealth of Pennsylvania, was received and filed for future reference. These recommendations were previously agreed upon at a meeting of the Mining Section of the Pennsylvania Stone Producers' Association held in Pittsburgh on April 26.

Robert S. Walker stated that he was desirous that the Association cooperate with the producers in the Central District in filing a complaint with the Interstate Commerce Commission and the Pennsylvania Public Service Commission, praying for a reduction in freight rates. It was not deemed advisable at this time to take action on the suggestion of Mr. Walker.

The meeting was then adjourned.

The Ohio Crushed Stone Association.

The regular monthly meeting of the Governing Board of The Ohio Crushed Stone Association was held at the offices of the Association in Columbus, Ohio, on Friday, May 14.

The meeting opened with a report from O. A. Brand, Chairman of the Ways and Means Committee, recommending that The Ohio Crushed Stone Association make a contribution to the National Crushed Stone Association in the sum of $1,000 for the remainder of 1926. Upon motion made by Mr. Brand, seconded by Mr. Brandon, the recommendation was unanimously carried.

The Ways and Means Committee further recommended that the work of the Ohio Good Roads Federation be endorsed. A report of the Ohio Good Roads Federation showed that various members of The Ohio Crushed Stone Association are contributing a total sum of $1,000 to that organization.

Upon motion of Mr. Brand, seconded by Mr. Brandon, the recommendation was approved and the Acting Secretary was instructed to write the members relative to this action.

Mr. Sharp reported on a recent conference held in the Highway Department between representatives of the stone and gravel industries and highway engineers relative to the comparative weights of stone and gravel. The conference dealt primarily with the weights of materials used in traffic bound constructions and it was mutually agreed that the weight of crushed limestone

should be taken as 2,400 pounds per cubic yard and gravel should be taken as 2,700 pounds per cubic yard, thus establishing a 300 pound differential. At the same conference the present specifications relative to the grading of these two materials was discussed. These specifications have permitted the use of more fine materials in the gravel aggregate than in the limestone agregate. It was also mutually agreed that the specifications governing these two materials should be the same.

Upon motion of Mr. Sharp, seconded by Mr. Brand, it was decided to recommend to the Ohio State Highway Department that the following changes be made in the State Specifications:

Recommended Changes in Specifications for Bituminous Macadam Surface Course of the Ohio State Highway Department

Gallons of Bituminous Materials
(Item T-3, page 30)

Depth	1st Application	Seal Coat	Final Seal Coat	Total
2½"	1.1 (1.5)	0.9 (0.7)	0.5 (0.3)	2.5
3"	1.5 (1.9)	1.0 (0.8)	0.5 (0.3)	3.0
3½"	1.75 (2.1)	1.25 (1.0)	0.5 (0.4)	3.5

Note: Where temperature is less than 50 degrees Fahrenheit, figures in parenthesis are to be used.

Under Paragraph "Aggregates" substitute No. 2½ size for No. 2 size.

On page 12, insert a new size, which might be called No. 2½ consisting of 95-100 passing 3 in. circular openings and 0-10 passing 2 in. circular openings.

Tonnage for penetration bituminous course to be figured by using .05 tons per sq. yd. per inch in thickness of the finished road.

The recommendations given above were suggested for the following reasons:

In too many instances where penetration macadam is built, there occurs raveling or loosening up of the top course the spring following construction. This we think is due: 1st, to the use of stone too small in size; 2nd, to applying of too much bituminous material on the first application and not enough on the second and third applications, which results in the bituminous material finding its way to the lower part of the wearing course, consequently, the smaller surface stones are not bound by the bituminous material. To remedy this condition, we feel the above recommended change in the amount of material applied in each of the three applications, together with the larger sized stone recommended will overcome raveling of bituminous surfaces and upper part of the course.

Also it is our belief that the wearing course exceeds the specified thickness from ½ to 1 in. in many instances. The result is not enough bituminous material per inch in thickness of the course; too small sized stone for the thickness of the course; and too deep penetration of the bituminous material.

We believe by using the factor .05 tons per sq. yd. per inch, together with the above recommended changes, this trouble of bituminous macadam surfaces raveling and dry surfaces, apparently deficient in bituminous material will be greatly, if not entirely, overcome.

Chairman Evans appointed the following committee for the purpose of bringing these recommendations to the attention of the engineer of the Highway Department: Messrs. Van Voorhis, Sharp and Brand.

On motion of Mr. McAllister, seconded by Mr. Brand, the meeting was adjourned.

Mid-West Division

The Mid-West Division of the National Crushed Stone Association held its regular meeting on May 21st at the Great Northern Hotel, Chicago.

The officers for 1925 were all re-elected for 1926 as follows: Chairman, Col. O. P. Chamberlain; Secretary, F. C. Murphy; Executive Committee, Col. O. P. Chamberlain, Dolese & Shepard Co., Chicago, Ill., W. R. Sanborn, Lehigh Stone Co., Kankakee, Ill., E. B. Taylor, Mid-West Crushed Stone Co., Greencastle, Ind., E. J. Krause, Columbia Quarry Co., St. Louis, Mo., F. C. Murphy, Brownell Improvement Co., Chicago, Ill.

Mr. Sanborn reported regarding the progress being made with the State Highway Department of Illinois on the proper gradation of materials for concrete road construction.

Mr. Taylor spoke on the activities of the stone producers in Indiana, after which the meeting closed with a general discussion regarding the outlook for a large distribution of Agricultural Limestone among the farmers.

After the meeting a very enjoyable luncheon was served in the Rural Room of the Great Northern.

Studies in Macadam Road Design

(*Continued from Page 4*)

breakage is progressive and is due to the lack of support offered by the base. With all of these sections decreased pressure intensity on the subgrade at the edges should result because of a better distribution of the loads, and in Figures I, III, IIIa, and IV lateral restraint is likewise provided. Also the use of shoulder drains and a granular sub-base under all sections on bad subgrades should increase the load resisting value of the subgrade.

The foregoing studies in cross-section design have been made for the purpose of improving the bituminous macadam road type so far as its ability to carry loads is concerned. All of these sections seem to hold promise of giving better service than the standard design, and where the cost is not materially increased it would seem that these revised sections are certainly worthy of a practical trial. They are here presented in order to stimulate further thought on the part of engineers to the end that finally there will result a design for bituminous macadam which will serve traffic at a lower yearly cost than present roads of this type. It is urged that highway departments give all of these ideas a thorough trial on short stretches in comparison with their present standard bituminous macadam cross-sections.

The CRUSHED STONE JOURNAL

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ROADS BILL CARRYING $165,000,000 GIVEN FAVORABLE REPORT

The Senate Committee on Post Offices and Post Roads on May 4 favorably reported out the House bill authorizing $165,000,000 for Federal aid in the construction of rural post roads.

The roads bill authorizes an appropriation of $75,000,000 for the fiscal year ending June 30, 1928, and a similar appropriation for the succeeding fiscal year, with $7,500,000 for forest roads and trails in each of those two fiscal years.

In its report on the bill, which passed the House of Representatives April 16 the House Committee on Roads reported that, "Never since the organization of this committee, has there been such general support for this legislation." It cited nine national organizations, in addition to the Bureau of Roads and the Forest Service Bureau of the Agriculture Department, which appeared before the committee in support of it. The nine organizations were:

American Association of State Highway Officials, American Automobile Association, American Bankers Association, American Farm Bureau Federation, American Federation of Labor (by resolution filed), National Grange, American Road Builders Association (by resolution filed), National Automobile Chamber of Commerce and the Chamber of Commerce of the United States.

—United States Daily.

DUBUQUE STONE PRODUCTS COMPANY PLANS EXTENSIVE IMPROVEMENTS

New machinery of the latest type is being installed by the Dubuque Stone Products Company, formerly the Eagle Point Lime Works, as a part of an extensive program of expansion which will place it among the foremost industries of its kind in the country.

Officers of the new company, whose products are lime, crushed stone, agricultural limestone, and rip rap, plan to leave nothing undone to insure their plant becoming a leader in its field. Officers of the company are:

President—G. D. Rose.
Vice President—J. C. Collier.
Secretary-Treasurer—Paul M. Nauman.

Equipment being added to the company's plant at Eagle Point includes a 30-inch gyratory crusher of the most modern design, weighing more than 175,000 pounds. This crusher, which will be the first step in reducing the size of the stone, has a capacity of 2,400 yards per 10-hour day. The machine has two openings, each 30 inches by 118 inches, and handles rock of 30-inch cube. It is constructed by the Traylor Engineering and Manufacturing Company, Allentown, Pa.

The new 30-inch crusher will be located in the quarry at Eagle Point and a 30-inch Stephens-Adamson belt conveyor will be installed to convey the material from the quarry, over the roadway, to subsidiary crushers.

More than $35,000 will be expended by the Dubuque Stone Products Company during 1926 for improvements. Nor will this be the extent of the expansion program, for additional improvements are contemplated for the succeeding years.

LOUISVILLE CEMENT COMPANY WINS TWO HONORABLE MENTIONS IN NATIONAL SAFETY COMPETITION

The first release of the Department of Commerce in announcing the winners of the National Safety Competition, which appeared in the May issue of the Crushed Stone Journal, was incorrect relative to those receiving honorable mention in the group of underground mines producing non-metallic minerals.

In the first release it was reported that honorable mention was accorded to the limestone underground quarry of the Alpha Portland Cement Co., at Milltown, Indiana. This was in error as the Milltown operations belong to the Louisville Cement Co.

This gives to the Louisville Cement Company the unusual distinction of winning two honorable mentions, one in the quarry and open pit mine group and the other in the group of underground mines producing non-metallic minerals.

IDEALS IN TRADE ASSOCIATIONS*

Ideals in any field of activity embody highest values attainable. To attempt to realize them is apt to discourage rather than to assist a person; yet they have practical power as regulative principles. They give the right direction and should be regarded as limits rather than objectives. They represent the best possible achievement. William James discusses an ideal in a manner applicable to the subject in hand.

"An ideal," he says, "must carry with it that sort of outlook, uplift and brightness that go with all intellectual facts. Secondly, there must be novelty in an ideal—novelty at least for him whom the ideal grasps. Sodden routine is incompatible with ideality, although what is sodden routine for one person may be ideal novelty for another. This shows that there is nothing absolutely ideal; ideals are relative to the lives that entertan them."

Leaders in the non-metallic mineral industries are giving their thought and energy to the successful attainment of the trade association ideal. Their efforts are motivated by an earnest desire to foster a spirit of progress and of wholesome competition that will prove to be increasingly beneficial. Men who aid in forward moving enterprises are prompted to do so by ideals. They are men of vision and imagination. They work for the success of the association because they have before them an ideal that is their inspiration. There is no "sodden routine" in their efforts but rather novelty, enthusiasm, "uplift and brightness."

Annual conventions of trade associations are indicative of the year's growth, but are not all there is to the organization. There is great pleasure and unquestioned benefit available for those who attend. They can scarcely realize how much hard work precedes the convention. Only because a few men have had ideals are the many members of the industry able to enjoy the numerous advantages of these annual meetings. The spirit of such leaders serves to solidify the organization; it makes possible a harmonious and profitable survey of the immediate future for which plans must be made.

Men are fundamentally individualists; they think in terms of self interest. Associations function in terms of group interest. They represent the group idea expressing co-ordination in terms of the whole. Men recognize the necessity of the group idea and organize associations. The function of the association is to do what the individual cannot accomplish alone. In order to succeed in this attainment there must be a certain subjection of the individual to conform with group ideals. This calls for unselfish devotion to the best interests of the group as a whole. If carried too far this subordination of the individual would hamper his development and stifle his imagination. If the principle of subordination is ignored, there develops a top heavy, clumsy, unwieldy organization which is crushed by its own weight.

If the group idea is to function satisfactorily, the members of the association must have confidence in the leaders and faith in the industry. They must be desirous of maintaining harmony and of contributing to progress. The paramount interest of the group is in the general welfare of the industry and the elimination of just causes of dissatisfaction. The primary relation of the group to the individual is that of assistance and cooperation in working out his line of conformance to the requirements of group benefit. Another function of the group is to correlate the results of individual effort to the solution of the common problems. Success in reaching these ideals lies in the wisdom of the leaders and the confidence of the members of the association.

The real aim of a trade association is to seek solutions of problems of mutual interest. It must operate for the benefit of the whole without interfering with individual freedom. It occupies a somewhat precarious position in its relation to the individual and to the whole. The individual expects to gain something from the association and may become dissatisfied if he is disappointed. It is the business of the association to convince the individual that he gains if there is a general gain. It requires vision to accept the theory that only through a general prosperity can the individual prosper.

The strength of the association rests with its members; its labors are dependent upon their cooperation. If it is to be of greatest possible value to the industry, it must receive the support of the individuals. The possibilities of what may be accomplished through trade associations are unlimited; the possibilities of weakness and of failure are equally great. The leaders cannot take the place of the membership, nor can the members be served effectively without leaders. Without organization there will be no future of consequence for any association; without leaders there will be no organization; without individual support there will be no leaders.

* Editorial in Pit and Quarry, Vol. 12, No. 5, June 1, 1926.

CRUSHED STONE FOR FILTER BEDS*

By Charles H. McAlister

Of Supply Distributors Corporation, Cleveland, Ohio

Of interest, nationally, to commercial crushed stone producers is the recognition by prominent engineers, of the value of well prepared crushed stone of proper quality as a medium for trickling filters in sewage disposal plants.

The prospects of finding an outlet for thousands of tons of crushed stone when such has the required physical properties and is carefully prepared, is brought directly to the attention of commercial stone producers by the action of the city of Akron, Ohio, in awarding one of the Ohio producers direct, a contract for 305,000 tons of stone to be used as a medium of filtration in the trickling filters of the new sewage disposal plant to be immediately constructed at Botzum, north of the Akron city limits.

Action in awarding the contract was taken after careful inspection and tests by competent engineers, at the direction of city officials, and some quarries inspected failed of approval because of the variable qualities of toughness and soundness.

Having in mind a probable requirement, by the city of Cleveland and the city of Akron, as well as other Ohio communities, for a suitable material for a filtering medium in trickling filters, and knowing of the general use of sound hard crushed stone as such, a few of the larger commercial crushed stone producers of Ohio, nearly a year ago, in attempting to find how well Ohio limestone would serve as an alternate to the eastern traps, for a filtering media, decided to have samples of their various quarries taken by an engineer of recognized standing, and thoroughly tested, particularly for soundness. These tests were intended to inform each producer with that which was fit or unfit. The samples were subjected to actual freezing and thawing, as well as to sodidium sulphate tests, both running concurrently. Tests to determine the toughness, hardness, per cent of absorption and cementing quality were applied to the samples selected at the quarries by an accredited representative of the engineer, and the results of these tests will be given for the benefit of all concerned as soon as the report is completed.

How the Filter Works

A trickling filter (called also a sprinkling or percolating filter) is an enclosure, with earth, stone or concrete walls, filled with pieces of carefully sized material called the filtering medium, overlying a system of collector pipes, or underdrains.

The sewage, after being settled to remove suspended matter, is intermittently sprayed, usually by means of automatically regulated sprays, evenly over the surface of the filter.

The applied liquid sewage trickles down through the bed, coming in contact with jelly-like films on the surfaces of the pieces of filtering medium where putrefactive organic matter is converted into a non-putrefactive condition by the innumerable bacteria and biological organisms present in the film. Under proper operating conditions, the sewage is discharged from the underdrain system well nitrified and stable.

For efficient results the beds must be well aerated. During cold weather, when bacteria are somewhat inactive, solid non-putrefactive matter accumulates within the filter but with the advent of warm weather, the activities of the bacteria increase and this stored matter becomes loosened and ordinarily sloughs off and passes out through the underdrains, thus maintaining the voids of air spaces in the filter.

In northern climates operation during the winter results in alternate freezing and thawing which necessitates the exclusive use of sound material, and in view of the preceding, it is obvious that the success of a trickling filter is largely dependent upon the physical properties, as well as the careful sizing, of the filtering medium.

A material which would disintegrate from any cause would tend to fill the voids and cause clogging. It should also be free from dust or other substances which would tend toward cutting down the voids. Furthermore, the surface of the material should be neither too rough nor too smooth. It should be such that the bacterial films will adhere to the individual particles and yet should not provide anchorage, through excessive roughness, pits, etc., to prevent the sloughing off and passing out of the solid matter stored through the period of bacterial inactivity.

*Rock Products, Vol. XXIX, No. 11.—May 29, 1926.

MANITOBA SEEKS $965,000 FOR ROAD CONSTRUCTION

Appropriations of $950,000 for roads in Manitoba and $15,000 for extension of the Trans-Canada highway to meet the Ontario highway at Kenora, Ontario, were included in supply estimates of the Province introduced in the Manitoba Legislature last week, the Department of Commerce is advised in consular reports.

—United States Daily.

AKRON TRICKLING FILTERS WILL USE 223,000 CU. YD. OF LIMESTONE*

By J. E. Root

Sewage Engineer, Department of Public Service, Akron, Ohio.

Approximately 223,000 cu. yd. of broken limestone at a contract price of $1.85 a ton or about $2.53 a cubic yard will be used in the 14 acres of 10-ft. trickling filters, which, with Imhoff tanks, will be the main features in the new sewage-works for Akron, Ohio. The design is based on an average of 33 m.g.d. sewage flow from an estimated future population of 260,000. The size of the stone will range from 1 to 2½ inches.

Before deciding on limestone a careful study of available filtering materials within a reasonable distance of Akron was made by the city officials as well as by their advisory engineers, Metcalf & Eddy. The leading limestone quarries in northwestern Ohio and the large slag plants in the Youngstown district were personally inspected and materials from these quarries and plants carefully considered. In addition, a study was made of the four acres of slag trickling filters which Akron has had in operation since January, 1917, treating Imhoff effluent, as will the new filters.

After the results of all the investigations, including tests of the stone and slag available, and upon the recommendation of the consulting engineers, the material to be used for the new filters was limited to a hard limestone rock to meet the following physical requirements: (1) Hardness, not less than 14 per cent. (2) Toughness, not less than 5. (3) Wear, not more than 6. (4) The stone shall show no signs of checking, cracking or disintegration after 20 successive treatments by the sodium sulphate test. The tests for hardness, toughness and wear follow the standard method for testing stone as a material for road construction.

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*From Engineering News-Record, May 20, 1926.